MULTIMEDIA UNIVERSITY

STUDENT ID NO

TABLE NO: _____

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

TCP2101 ALGORITHM DESIGN AND ANALYSIS / TCS3211 ALGORITHM ANALYSIS

(All sections/groups)

15 OCTOBER 2018
9.00 a.m. – 11.00 a.m.
(2 Hours)

Question	Mark
1	
2	
3	
4	
Total	

INSTRUCTIONS TO STUDENTS

1. This question paper consists of fifteen (15) printed pages only including the cover page.
2. There are four (4) questions in this paper.
3. Answer **ALL QUESTIONS**. All questions carry equal marks (25 marks) and the distribution of the marks for each sub-question is given.
3. Please write all your answers **in the spaces provided in this question paper**.

Question 1

a) The following operations are found in many algorithms you have studied. State the worst-case running time for each operation and write down the answer in the space provided on the right using one of the following possibilities (note that the running times may be repeated and is NOT a one-to-one match)

`1` `n` n^2 `logn` `nlogn`

[5 marks]

Operation	Worst-case running time
Inserting item to beginning of a *list*	
Inserting an item into a *tree*	
Delete an item from the end of a *list*	
Check if *list* has an item	
Find biggest item in a *heap*	

b) Given five computer algorithms with running time complexities of $O(n^2)$, $O(n^3)$, $O(\log n)$, $O(n \log_2 n)$, and $O(n^2 \log n)$. Arrange them according to descending growth rate.

[4 marks]

c) What are the best and worst case time complexities for searching an item in hash tables? Under what conditions will the best case and the worst case occur?

[4 marks]

Continued...

d) The following sequence of 5 numbers are inserted into the hash table below using the hash function h(k) = k mod tablesize

22 33 11 1 18 44

Calculate and fill in the hash tables below with the values based on the stated collision strategies. Use the empty space below to explain/show the calculations required to fill in the hash table.

[6 marks×2]

Linear probing

h(k)	0	1	2	3	4	5	6	7	8	9	10

Quadratic probing

h(k)	0	1	2	3	4	5	6	7	8	9	10

Continued...

Question 2

a) What makes an *Adelson-Velskii Landis* (AVL) tree different from a normal binary search tree?

[3 marks]

b) Show how an AVL tree is created with the letters from the word 'ALGORITHM'. Draw the tree for each individual step as the letters from the word are inserted in the space below.

[8 marks]

Continued...

Continued...

c) From the AVL tree you obtained in (b) above, list down the in-, pre- and post-order traversals.

[6 marks]

d) What is the running time for performing search operations in an binary search tree and an AVL tree?

[2 marks]

e) Using the same letters from the word 'ALGORITHM', show how a *heap* can be created if you assume that the letters are numbered accordingly to their positions (i.e. A=1, B=2 etc.) and the sequence is treated as a single input array.

[6 marks]

Continued...

Continued...

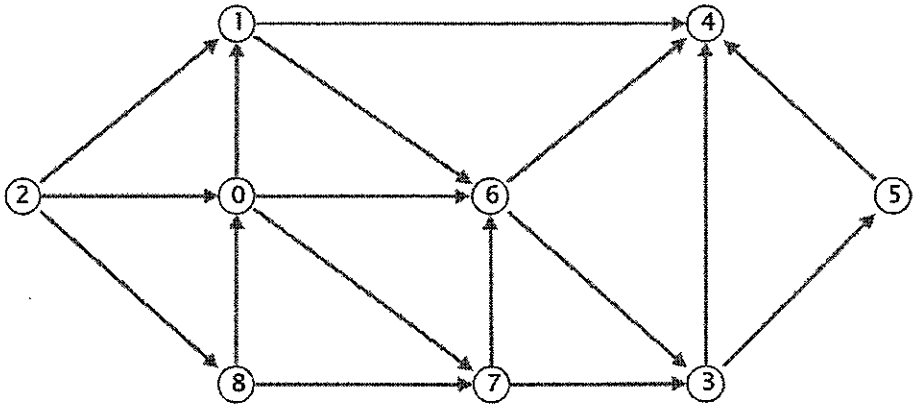
Question 3

a) Graphs can be represented as an adjacency list or as an adjacency matrix. Which representation **uses more space** in representing a **sparse** graph? **Explain** your answer. What are the **space complexities** of an adjacency list and an adjacency matrix respectively for a sparse graph?

[4 marks]

b) Show the adjacency matrix and adjacency list for the given acyclic digraph in the space below

[9 marks]



Continued...

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c) Use dynamic programming to find the optimal matrix chain-product for the following 5 matrices =

P1: 2×4 P2: 4×3 P3: 3×5 P4: 5×2 P5: 2×3

Complete the DP table below with the optimal solution calculated from the multiplication of matrix chain. Show your calculations in the space below.

[7 marks]

	P1	P2	P3	P4	P5
P1	0	24			
P2		0	60		
P3			0	30	
P4				0	30
P5					0

Continued...

d) The following table has six items along with its weight and value. Using the 0/1 knapsack algorithm, complete the table below to identify the items to choose which will provide the highest benefit if the knapsack size is 15. At the end, list down the maximum benefit and the items selected in order to obtain that benefit value.

Item	A	B	C	D	E	F
Weight	5	8	9	7	9	13
Value	7	9	8	8	10	12

[5 marks]

Item\Weight	{}	{A}	{A,B}	{A,B,C}	{A,B,C,D}	{A,B,C,D,E}	{A,B,C,D,E,F}
15							
14							
13							
12							
11							
10							
9							
8							
7							
6							
5							
4							
3							
2							
1							
0							

Items selected to get maximum benefit : _____

Continued...

Question 4

a) Use Master Theorem to find the time complexity (in big-O) for the following three equations. The three cases of Master method are shown below:

i. $T(n) = 7T(n/3) + n^2$
ii. $T(n) = 4T(n-3) + n$
iii. $T(n) = 8T(n/2) + n \log^3 n$

The Master Theorem:

1. if $f(n)$ is $O(n^{\log_b a - \varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a} \log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a} \log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a + \varepsilon})$, then $T(n)$ is $\Theta(f(n))$,
   provided $af(n/b) \leq \delta f(n)$ for some $\delta < 1$.

[9 marks]

Continued...

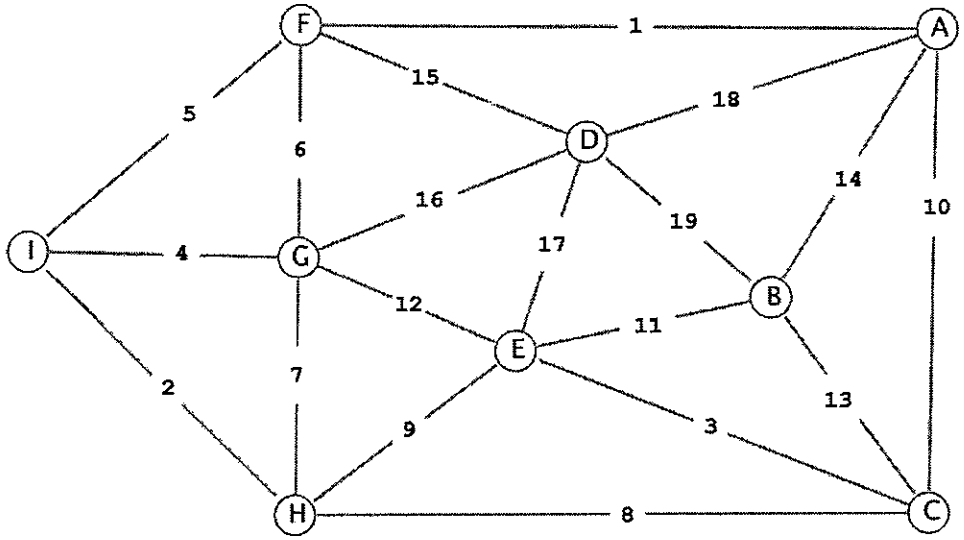
b) Show the steps taken if the Boyer-Moore algorithm is used to find the word 'TEXT' in the phrase below

```
HERE IS A SAMPLE TEXT TO SEARCH IN FOR THE TEST
```

[6 marks]

Continued...

c) Using the weighted undirected graph below, show the individual steps in Prim-Jarnik's algorithm to find the minimum spanning tree and its total weight. For brevity reasons, you do not need to draw the entire graph in each step, just the path added to the existing tree from previous steps. Start the MST from node A in your answer.



[10 marks]

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End of paper

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